

PATENT COOPERATION TREATY

10619467 PCT/FI00/00397

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE
in its capacity as elected Office

Date of mailing (day/month/year) 18 January 2001 (18.01.01)	
International application No. PCT/FI00/00397	Applicant's or agent's file reference 991111 WO
International filing date (day/month/year) 04 May 2000 (04.05.00)	Priority date (day/month/year) 14 May 1999 (14.05.99)
Applicant NYMAN, Bror et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
29 November 2000 (29.11.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer <p style="text-align: center;">Nestor Santesso</p> Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

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From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING
OF A CHANGE

(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

OUTOKUMPU OYJ
Intellectual Property Management
P.O. Box 27
FIN-02201 Espoo
FINLANDE

Date of mailing (day/month/year) 13 December 2000 (13.12.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 991111 WO	
International application No. PCT/FI00/00397	International filing date (day/month/year) 04 May 2000 (04.05.00)

1. The following indications appeared on record concerning:	
<input type="checkbox"/> the applicant	<input type="checkbox"/> the inventor <input checked="" type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address OUTOKUMPU OYJ Patent Services P.O. Box 27 FIN-02201 Espoo Finland	State of Nationality
	State of Residence
	Telephone No. 358-9-4211
	Facsimile No. 358-9-4212978
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:	
<input type="checkbox"/> the person <input type="checkbox"/> the name <input checked="" type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence	
Name and Address OUTOKUMPU OYJ Intellectual Property Management P.O. Box 27 FIN-02201 Espoo Finland	State of Nationality
	State of Residence
	Telephone No. 358-9-4211
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3. Further observations, if necessary:	
4. A copy of this notification has been sent to:	
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The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Aino Metcalfe
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PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

P567 11 JUN 2001

WIFO

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Applicant's or agent's file reference 991111 WO	<div style="display: flex; justify-content: space-between;"> <div>FOR FURTHER ACTION</div> <div>See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)</div> </div>	
International application No. PCT/FI00/00397	International filing date (<i>day month year</i>) 04.05.2000	Priority date (<i>day month year</i>) 14.05.1999
International Patent Classification (IPC) or national classification and IPC7 B01D 11/04, C22B 3/26 // C22B 15:00		
Applicant Outokumpu Oyj et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability: citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 29.11.2000	Date of completion of this report 15.05.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Telex P.O. Box 5055 17979 S-102 42 STOCKHOLM FATOREG-S	Authorized officer Lars Ekeberg/js Telephone No. 08-782 25 00

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00397

I. Basis of the report

J. With regard to the **elements** of the international application:*

- ☒ the international application as originally filed
- ☐ the description:
 pages _____ . as originally filed
 pages _____ . filed with the demand
 pages _____ , filed with the letter of _____
- ☐ the claims:
 pages _____ . as originally filed
 pages _____ . as amended (together with any statement) under article 19
 pages _____ . filed with the demand
 pages _____ , filed with the letter of _____
- ☐ the drawings:
 pages _____ . as originally filed
 pages _____ . filed with the demand
 pages _____ , filed with the letter of _____
- ☐ the sequence listing part of the description:
 pages _____ . as originally filed
 pages _____ . filed with the demand
 pages _____ , filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00397

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-18</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-18</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-18</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The invention according to claims 1-18 relates to a method for extraction of copper from an aqueous solution containing a large amount of sulphates in liquid-liquid solution. The viscosity of the extraction solution lies between 3 and 11 cP. The between the extraction solution and the aqueous solution is situated between 0.7 and 1.0.

The following documents are, among others, cited in the International Search Report:

D1: GB 2 117 666 A

D2: US 4,221,658 A

D3: US 5,662,871 A

D4: US 5,185,081 A

Of these documents D1 and D2 were considered to be of particular relevance, while D3 and D4 only were considered to represent the general state of the art, and are therefore not discussed in this report. However, the importance of D1 and D2 have been re-evaluated. They are now only considered to represent the general state of the art.

From D1, a method for hydrometallurgical extraction of copper is known. The ratio between the extraction solution and the aqueous solution is preferably situated around 1.0 (claim 9).

Another extraction method is known from D2. In both D1 and D2 the preferred volume ratio is situated between 0.2 and 5. Nothing is, on the other hand, said about the viscosity, in neither of the documents. It is not suggested that an augmentation of the viscosity could have a positive influence on the extraction.

.../...

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00397

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V (I)

Although it is difficult to estimate the viscosity of the solutions used in D1 and D2, the invention is considered to involve an inventive step with regard to both of these documents. Claims 2 -18 are dependent on the first claim, hence, these claims are also considered to possess an inventive step.

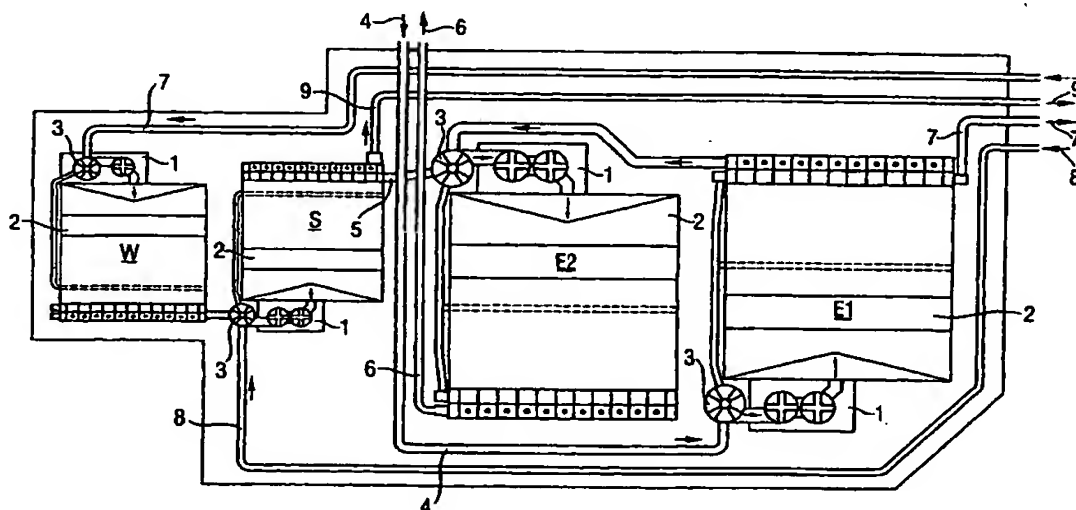
In view of the argument stated above, the invention as a whole is novel and considered to involve an inventive step. It is also considered to fulfil the criteria of novelty and industrial applicability.



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(22) International Filing Date: 4 May 2000 (04.05.00)			
(30) Priority Data: 991111 14 May 1999 (14.05.99) FI			
(71) Applicant (for all designated States except US): OUTOKUMPU OYJ [FI/FI]; Riihitontuntie 7, FIN-02200 Espoo (FI).		Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	
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(54) Title: A METHOD FOR EXTRACTING COPPER FROM AN AQUEOUS SOLUTION



(57) Abstract

The invention relates to a method for extracting copper in liquid-liquid solvent extraction from aqueous solution with a high sulphate content, by raising the viscosity of the extraction solution and by dispersing the aqueous solution into drops, achieving a dense drop aggregation. The viscosity of the extraction solution may be raised either by increasing the content of the actual extractant, the extraction reagent, in the extraction solution or by using a diluting agent with a higher viscosity than that of the diluting agent normally used. By raising the viscosity of the extraction solution the mixing durability of the extraction dispersion can be increased and resulting of that the amount of residual drops is decreased. Other advantages are that the extraction solution flow of the extraction process decreases in relation to the flow of the aqueous solution acting as the copper source and that the size of the extraction equipment needed is reduced.

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A METHOD FOR EXTRACTING COPPER FROM AN AQUEOUS SOLUTION

The present invention relates to a method for extracting copper in liquid-liquid solvent extraction from aqueous solutions with a high sulphate content, by raising the viscosity of the extraction solution and by dispersing the aqueous solution into drops, achieving a dense drop aggregation. The viscosity of the extraction solution may be raised either by increasing the content of the actual extractant, the extraction reagent, in the extraction solution or by using a diluting agent with a higher viscosity than that of the diluting agent normally used. By raising the viscosity of the extraction solution the mixing durability of the extraction dispersion can be increased and resulting of that, the amount of residual drops is decreased. Other advantages are that the extraction solution flow of the extraction process decreases in relation to the flow of the aqueous solution acting as the copper source and that the size of the extraction equipment needed is reduced.

Dilute aqueous solutions form when poor copper ores are leached directly. The copper content of such solutions is usually of the order of 1 – 4 g/l Cu. In addition neutral salts often accumulate in the solution, mainly aluminium and magnesium sulphates. Although the copper content does not rise above 1.5 g/l, the sulphate content may rise above 40 g/l, to between 40 and 120 g/l. Some of the sulphate may originate from the ore or the possible use of seawater. In the extraction process the aqueous solution is in a cycle between the extraction and the leaching and thus gradually accumulates the salts which raise the viscosity. Neutral salts can easily cause a viscosity increase harmful to the aqueous solution, even 3 cP, which also disturbs the dispersing of the aqueous and extraction solutions and results in high amounts of residual drops. In particular when dispersion is desired where the organic solution is continuous and the water in drops, an increase in viscosity in the aqueous solution can make it difficult to achieve such a dispersion. Previously

the increased viscosity caused by neutral salts and the resulting disadvantages were not taken into account.

In copper extracting processes a mixed organic extraction solution and aqueous solution is generally used in the ratio of O/A (organic/aqueous) 1.0 – 1.2. Present-day copper extracting processes usually follow recommendations given by extractant manufacturers, according to which the organic and aqueous solution of the extraction O/A ratio at all extraction stages of the extraction process should be of the order of 1.0, and the extractant content raised to 3.3 – 4.2 vol.% per every gram of copper, which comes in the direction of flow of the first extraction stage of extraction. In practice this means that if the Cu content of the aqueous solution is 1.5 g/l, the extractant content is maximum 6.3 vol.% according to the recommendations. Generally, when the amount of copper in the solution increases, the amount of extractant decreases relatively. The type of extractant is a chelating copper complexing agent, usually hydroxyoxime, which forms a strong complex with copper, and one fact affecting the progress of copper extraction is how much extractant is present in relation to the amount of copper to be extracted.

Generally, alifatic or aromatic hydrocarbons, kerosenes, with a distillation range between 190 – 245 °C are used as the diluting agent for the copper extractant. The viscosity of these substances is usually below 2 cP, and for aromatics even below 1.5 cP. It is also possible to use mixtures of aromatic and alifatic hydrocarbons as the diluting agent, where the aromatic content of the mixture is around 20 – 30 vol.%.

As previously stated, in copper extraction it is difficult to get a dispersion of an aqueous solution with a high sulphate content, minimum 40 g/l, where the organic phase is continuous and the aqueous solution in drops, although this is essential in order to improve extraction performance. According to the present invention, the viscosity of the extraction solution is now raised to the

area of 3 –11 cP, and this takes place either by raising the extractant content or by using a diluting agent with a high viscosity in the extraction solution. In addition to this, that the organic phase has been made continuous, the method has proved to have many other advantageous consequences. The essential features of the invention will become apparent in the attached patent claims.

A rise in the viscosity of the extraction solution clearly raises the mixing durability of the extraction dispersion. In this connection a mixing-durable dispersion means a dispersion where no drops below 0.2 mm appear when the mixing intensity is max. 0.15 kWh/m³ in a mixing volume of 50 m³. Volume-specific mixing power is dependent on the mixing volume so that the power required decreases slightly as the volume increases. Obviously the mixing itself also affects mixing durability. The mixers described in US patent 5,185,081 have been settled on to use in the method according to the present invention. These mixers have a double helix, which helps to avoid locally increasing shear rate forces and the small drops generated as a result. When the viscosity of the organic phase has been raised according to the invention and the extraction dispersion made heavier and this dispersion combined with a very smooth, thoroughly uniform mixing of controlled intensity in the mixing area, the conditions are achieved where an evenly distributed mixing energy is not sufficient to attain a turbulence to form droplets. An evenly attenuated mixing creates a dispersion where the drop size is uniform and which thus possesses good separation characteristics. Since the amount of residual drops is small, the extraction result is clearly improved.

In addition to the increase in viscosity of the extraction solution, another key factor is the mixing ratio of the solutions. The denser the drop aggregation, the heavier and simultaneously more mixing-durable the dispersion. The most advantageous result is obtained when a dispersion is formed, where the extraction solution is continuous and the amount of water drops is raised.

When the viscosity of the extraction solution is raised, it has been found that an extraction solution with a higher viscosity is better able to keep a larger amount of the aqueous solution than normal inside it as drops. In the method according to our invention it is possible to lower the O/A ratio to between 0.7 – 1.0 without endangering the continuity of the extraction solution. In practice, this means that the extraction solution flow can be reduced in relation to the copper-containing feed solution (the aqueous solution) by the amount previously described. At the same time the extractant content of the extraction solution is increased to the extent that the mass flow of the extraction solution stays unchanged or increases a little. Thus the viscosity of the extraction solution can be raised successfully.

The factor by which the extractant content is raised compared with the normal recommendation in the method according to the present invention, varies between 1.2 – 5, and is preferably between 1.5 – 3. When very dilute copper-containing feed solutions with max. 2 g/l of copper are being treated, the factor may always rise to 5 i.e. according to our invention the extractant content would then be of the order of 7 – 25 vol.%, preferably 15 – 25 vol. %. When the feed solution copper content is between 2 – 4 g/l, the preferred extractant content is in the range of 15 – 30 vol.%. Generally, however, the extractant content does not increase above a content of 30% by volume. The viscosity of the extraction solution in this case rises to between 3 – 7 cP, which is enough to raise it to a clearly higher level than the viscosity of the aqueous solution. Normally, the aim is to achieve an O/A viscosity ratio of between 1.2 – 3, preferably 1.5 – 2. According to the invention, when extracting dilute copper solutions the extractant content in the extraction solution is presently set in the range of 7 – 30 vol.%, preferably 15 – 30 vol. %.

Regarding aqueous solutions containing over 4 g/l of copper, even an ordinary extractant content in the extraction solution gives a fairly good result. For these solutions, the use of an extractant factor of 1.2 – 2.0 times the

recommendation improves the mixing durability of the dispersion. With the method according to the invention, however, it is possible to raise the extractant content in the extraction solution to 25 – 50 vol.%, when the copper content of the aqueous solution is 4 – 8 g/l and even up to 40 – 70 vol.% if the copper content of the solution is over 8 g/l. The viscosity of the extraction solution can also be raised partly or wholly with the use of a diluting agent. The distillation range and viscosity of the diluting agents generally used was mentioned earlier as being rather low. If other diluting agents are used, this can also raise the viscosity of the extractant. Alifatic hydrocarbon products can be chosen with a distillation range in the range of 220 – 275 °C or 240 – 270 °C, and the viscosity of these substances measured at a temperature of +25 °C is 2.7 or 3.2 cP. If it is desired to use aromatic hydrocarbons, the viscosity of hydrocarbons with a distillation span of 230 – 290 °C is about 3 cP. It is also possible to use mixtures of alifatic and aromatic hydrocarbons.

When treating dilute aqueous solutions containing less than 4 g/l of copper, there is a possibility in our invention of using hydrocarbon compounds that boil at a high boiling range as the diluting agent. The use of a diluting agent to increase viscosity is preferred since the diluting agent is always cheaper than the actual extractant. The proportion of diluting agent in the extraction solution can be between 30 – 93%. It is easier to achieve the required rise in viscosity without the density of the extraction solution increasing significantly with alifatic hydrocarbons. The use of alifatic hydrocarbons is also recommended for reasons of industrial hygiene.

It was mentioned above that when raising the viscosity of the extraction solution it is possible to decrease the external pumping of the extraction solution coming to the extraction stage from outside. If the rise in viscosity takes place with an extraction solution diluting agent, it is not possible to decrease pumping. On the other hand, when viscosity is raised with an extractant, external pumping of the extraction solution can be reduced

significantly compared with the amount of copper-containing aqueous solution being conveyed to the extraction stage. If viscosity is raised both by increasing the extractant content and by using the aforementioned diluting agent, the amount of external pumping decreases in the same degree as the
5 extractant content is increased.

The method according to our invention is described in the attached drawings, where

10 Figure 1 shows a schematic view of the equipment used in the method of the present invention,

Figure 2 shows a stage calculation of the prior art, where the copper content of the aqueous solution (PLS = pregnant leach solution) coming to the extraction stage is 1.5 g/l and the extractant content of the extraction solution is 5 vol. % Acorga M 5640,

15 Figure 3 shows a stage calculation according to the present invention, where the copper content of the PLS is 1.5 g/l and the extractant content of the extraction solution is 15 vol. % Acorga M 5640,

Figure 4 shows a stage calculation according to the present invention, where the copper content of the PLS is 1.5 g/l and the extractant content of the
20 extraction solution is 25 vol. % Acorga M 5640,

Figure 5 shows a stage calculation according to the prior art, where the copper content of the PLS is 3.0 g/l and the extractant content of the extraction solution is 8.5 vol. % Acorga M 5640,

Figure 6 shows a stage calculation according to the present invention, where
25 the copper content of the PLS is 3.0 g/l and the extractant content of the extraction solution is 15 vol. % Acorga M 5640,

Figure 7 shows a stage calculation according to the present invention, where the copper content of the PLS is 3.0 g/l and the extractant content of the extraction solution is 25 vol. % Acorga M 5640,

Figure 8 shows a stage calculation according to the present invention, where the copper content of the PLS is 6.5 g/l and the extractant content of the extraction solution is 22 vol. % Acorga M 5640,

Figure 9 shows a stage calculation according to the present invention, where
5 the copper content of the PLS is 6.5 g/l and the extractant content of the extraction solution is 30 vol. % Acorga M 5640,

Figure 10 shows a stage calculation according to the present invention, where the copper content of the PLS is 6.5 g/l and the extractant content of the extraction solution is 40 vol. % Acorga M 5640,

10 Figure 11 shows a stage calculation according to the present invention, where the copper content of the PLS is 2.5 g/l and the extractant content of the extraction solution is 40 vol. % LIX 984N, and

Figure 12 shows a stage calculation according to the present invention, where the copper content of the PLS is 32 g/l and the extractant content of the
15 extraction solution is 50 vol. % Acorga M 5640.

Figure 1 describes a copper extraction process for treating dilute copper solutions. The process consists of two extraction stages, E1 and E2, one extraction solution washing stage W and one extraction solution stripping
20 stage S. Both the extraction stages and the washing and stripping stages consist of a mixing section 1, a settler 2, and a pump 3 used to transfer the dispersion. The mixing section has at least one mixer, which is preferably equipped with the mixing devices described earlier. The principles of the extraction stages are the types described in e.g. WO patent application
25 publications 97/40899, 97/40900, 97/40901 and 97/41938.

As usual, the extraction functions on a counterflow principle, whereby aqueous solution 4 comes first to extraction stage E1 and extraction solution 5 to stage E2. The aqueous solution exiting the final extraction stage E2,
30 raffinate 6, is fed back to ore leaching, and copper-enriched extraction solution 7 is fed from E1 to washing W and stripping S. In practice, the

5 extraction solution is circulated via storage tanks. The electrolyte 8 is fed from electrolysis to the stripping stage where the copper contained in the organic phase is extracted. The aqueous solution 9 containing copper sulphate exiting the stage goes as rich electrolyte to electrowinning and the stripped organic phase 5 is circulated back to extraction stage E2.

10 Figure 1 shows how considerably the size of the washing and stripping stages of the extraction process is reduced when an extractant is used according to the invention to raise the viscosity of the extraction solution. In fact the reduction is in direct ratio to the external extraction solution pumping, because the mixer-settlers in question are dimensioned directly with the solution flows in all respects, pumping, mixing and solution separation.

15 Therefore, in cases where the extractant content is raised for example to double the amount normally used, and external extraction solution pumping is correspondingly decreased to half the normal flow, the mixer and settler volumes of the washing and stripping stages are halved. The actual extraction stages E1 and E2 remain almost their earlier size and the same external extraction solution pumping goes through them, but the extraction solution can
20 be circulated within the stages in order to maintain extraction solution continuity. The extraction solutions flow through each stage of the extraction equipment at essentially the same time. As mentioned above, the O/A mixing ratio of the solutions may be reduced according to the method of the invention to below 1 to a value between 0.7 – 1.0, and the size of the extraction stages
25 equipment can be reduced correspondingly.

When estimating the effect of our invention on the size of the extraction equipment, it should be noted that Fig. 1 is only indicative of the relative size of the extraction stages and that of the washing and stripping stages. There
30 are often two stripping stages in an extraction plant and in some cases also two washing stages. Then the savings made by reducing the size of the

equipment are correspondingly greater. The amount of extraction solution inside the extraction plant is also reduced correspondingly even if the changes in the amount of extractant itself are not large, since the content of extractant in the extraction solution has been raised. In certain cases it is expedient even to raise the amount of extraction agent circulating in the process, so that the advantages described in the method can be achieved in full measure.

The method according to our invention provides the opportunity to treat difficult impurities such as copper ore containing chloride, nitrate or manganese in an economical way. In particular, ores containing a lot of iron are generally problematic, because iron increases the transfer of the above-mentioned impurities to the electrolyte via the extraction solution. This results in a situation where it is even more important than before to prevent the transfer of said impurities first to the extraction solution with the unseparated drops of aqueous solution from extraction stage E1 to washing stage W and from there on to stripping stage S.

According to our invention it is now possible to use equipment that is smaller than usual in the washing stage, but as it is known on the other hand, a prolonged settling time in the washing stage (larger settler) improves the separation of impurities. Now it is possible to enlarge the washing stage, in particular its settler section in relation to the extraction solution flow used, for instance the size of a settler according to the conventional method without increasing costs and to achieve better separation of impurities than before. In practice this means that in the washing and stripping stages the mixing and separating times are longer, i.e. the solutions flow through them more slowly than through the actual extraction stages. With this system our method offers the possibility for flexible, case-specific dimensioning.

When poor copper ores are processed by direct leaching, the result, as stated above, is an aqueous solution with a copper content in the range of 1 – 4 g/l, and in addition neutral salts accumulate in the solution. The sulphate content of the solution may rise to between 40 – 120 g/l, which causes a rise in the viscosity of the aqueous solution, but on the other hand, sulphate has the benefit of acting as a pH buffer when using copper extraction in the pH range of 0.8 – 2.2. In other words it improves the equilibrium of the copper extraction and makes more copper transfer to the extraction solution.

10 Example 1

A series of tests were carried out, which show that the separation of the organic solution and the aqueous solution from each other improves when the viscosity of the organic phase is raised by increasing the extractant content in copper extraction according to our invention. Table 1 presents the composition of the extraction solution and the results obtained.

The aqueous solution was made using ion-exchanged water, copper sulphate and sulphuric acid. The copper content of the solution was 2 g/l, the sulphate content 52 g/l and the pH 1.8. The extraction solution was prepared by mixing the commercial extractants shown in the table in different proportions with a commercial kerosene solution D70 as diluting agent. Mixing contact was made between the extraction solutions and the copper sulphate solution (aqueous solution) at room temperature and in the O/A phase ratio of 1.0, thereby obtaining the copper content values of the solutions in the table. After mixing all the solutions were recovered and stored for two weeks before the actual mixing tests. This ensured that the extraction solutions in particular corresponded to the solutions used in normal extraction, without the drawbacks of new extraction solutions.

30 A double helix agitator as described in US patent 5,185,081, with a diameter of 152 mm and height of 174 mm was used in the mixing tests. The mixer itself

was a flat-bottomed cylinder with a diameter of 214 mm and effective solution depth also of 214 mm. The cylinder was equipped with four baffles positioned on the frame of the cylinder, with a width of 18 mm and at a distance of 3.5 mm from the inner surface of the cylinder.

5 The mixing contact itself was made at room temperature and in the O/A phase ratio of 1.0 so that the extraction solution was continuous in all tests and the aqueous solution in drops. The revolution speed of the mixer was 220 rpm and the duration of mixing was 3 minutes in all tests. In all tests each extraction
10 solution was mixed with a new batch of the aqueous solution. After mixing the solutions were made to separate by the effect of gravity. 15 minutes after mixing the amount of residue solution in each of the separated solutions was determined. The drop residues (entrainment levels) are shown in Table 1, where A/O means water in the extraction solution and O/A means organic
15 phase drops in the aqueous solution.

Table 1

Test	Extr.sol.				Viscos.	Cu/extr.sol.	Residual drops	
	Extractant		Dil. agent				A/O	O/A
		tit.-%		tit.-%	cP	g/l	ppm	ppm
1	Acorga M5640	5	D70	95	2,7	2	500	90
2	Acorga M5640	8,5	D70	91,5	3	3,5	450	70
3	Acorga M5640	15	D70	85	3,3	6,2	150	40
4	Acorga M5640	25	D70	75	4,2	7,4	100	25
5	Acorga M5640	30	D70	70	4,9	13,7	150	25
6	LIX984N	40	D70	60	6,1	19,8	50	15
7	Acorga M5640	50	D70	50	8,2	20,1	50	12

20 The tests show that raising viscosity by increasing the extractant (extraction reagent) content clearly decreases the amount of residual drops in the settled solutions.

Example 2

An aqueous solution was prepared with a copper content of 1.5 g/l, sulphat content of 50 g/l and pH of 1.8. Three different extraction solutions were also prepared:

- | | | | |
|----|----|--------------|-------------|
| 5 | 1. | Acorga M5640 | 5.0 vol.-% |
| | | D70 | 95 vol.-% |
| | 2. | Acorga M5640 | 15.0 vol.-% |
| | | D70 | 85 vol.-% |
| | 3. | Acorga M5640 | 25.0 vol.-% |
| 10 | | D70 | 75 vol.-% |

The first solution represents an extraction solution according to the prior art.

Extraction equilibrium curves EEQ and stripping equilibrium curves SEQ
15 shown in Figs 2, 3 and 4 were defined for the extraction solutions and aqueous solutions in question with the method used by experts in this field. Diagram 2 shows the prior art, diagrams 3 and 4 the method according to this invention. Next, making use of the equilibrium data in question, an extraction calculation was made for a copper extraction process with two extraction
20 stages functioning on the counterflow principle and two stripping stages. The calculation was made on the basis of the McCabe-Thiele method, familiar to specialists in the field. The extraction and stripping stages reach as far as the equilibrium curve, because the stage efficiency is very high when using for instance the equipment described in WO patent publications.

25

The three stage calculations presented in the example show that the copper extraction yield remains at a good level and almost unchanged, even though the external pumping of the extraction solution is reduced. The copper contents of the raffinate are in all cases 0.2 – 0.4 g/l. The lowest content is
30 obtained by raising the extractant content to 15%, where by the external pumping of the extraction solution can be reduced to 35% of the PLS

(pregnant leach solution) feed i.e. copper-containing aqueous solution feed. It is apparent from the stage calculation in question that the extraction equilibrium remains good in extraction conditions (the EEQ curve rising steeply when the Cu content of the aqueous solution is under 0.5 g/l) over its
5 extraction solution copper content level, set for the extraction solution after the second stripping stage S2 (dotted line BO, e.g. 3.0 g/l in Figure 3).

Another essential factor is that the stripping equilibrium allows the making of strong copper electrolyte when the copper content of the extraction solution
10 can be lowered sufficiently. This means the level where the extraction equilibrium is still rising sharply in an aqueous solution Cu content of under 0.5 g/l, as stated earlier. The stage calculation reveals that with the method according to the present invention, a significant improvement is achieved in the copper content of the electrolyte going to copper electrolysis. With two
15 stripping stages the electrolyte was made almost saturated as regards copper sulphate.

In different stage calculations the copper electrolyte developed as follows: in a normal copper process (extractant content 5 vol.%) the copper content of
20 the "poor" electrolyte (LEL = lean electrolyte) coming to the washing stage is to be kept as low as 34 g/l and in the "rich" electrolyte (REL = rich electrolyte) the content may rise to the value of 42.5 g/l. In the present method the corresponding values are 36 g/l and 50 g/l when using an extractant content of 15 vol. % and 36 g/l and 51.5 g/l when using an
25 extractant content of 25 vol. %.

In the method according to the present invention a smaller amount than usual of extraction solution is circulated in relation to the PLS solution. Likewise the electrolyte circulation is correspondingly much smaller. In order
30 to describe the information included in the stage calculations the circulation of the solutions can be checked for instance on the basis of diagram 3. The

stage calculation is in two parts: extraction on the left and stripping on the right. The solution compositions of the different stages can be seen at the intersection points of the stages and the equilibrium curves. For example, in extraction stage E1 the Cu content of the aqueous solution decreases from the PLS content of 1.5 g/l to 0.6 g/l and the Cu content of the extraction solution rises from the E2 content of 4.2 g/l to 6.7 g/l. In stripping stage S1 the extraction solution on the other hand falls from an LO (loaded organic) value of 6.7 g/l to 4.2 as the Cu content of the copper electrolyte rises from 40.4 g/l to 50.0 g/l. The Cu content of the extraction solution falls further to a BO (barren organic) value of 3.0 in stripping stage S2, from where the extraction solution moves on to extraction stage E2 of the extraction.

The important points in said stage calculations are the so-called operating lines which indicate the contents in which the solutions touch each other when entering or leaving the first extraction and stripping stages E1 and S1 and the final extraction and stripping stages E2 and S2 and in between said stages. From the nature of the stage calculations it follows that the gradient of the operating lines indicate the external solution pumping i.e. the ratio of PLS and extraction solution flows in extraction as well as the ratio of electrolyte and extraction solution flows in stripping. It has been possible to calculate from the external pumping ratios how much the electrolyte circulation is reduced with our method in relation to the amount of PLS flow.

Certain figures characteristic of our invention have been assembled in Table 2, when the extractant contents of the extraction solution are 15 and 25 vol.% and these figures are compared with figures for conventional copper extraction, where the extractant content is 5 vol. %. The copper content of the aqueous solution (PLS) is 1.5 g/l in all cases. The extractant is Acorga M5640 and the diluting agent kerosen D70. The temperature of the extraction solution is 18 °C.

Tabl 2

Quantity	Kuva 2	Kuva 3	Kuva 4
Extractant content, vol-%	6	15	25
Viscosity of extraction solution, cP	2,7	3,3	4,2
Cu content of raffinate, g/l	0,3	0,2	0,4
Rise in Cu content of extraction solution, g/l	1	3,7	4,9
Rise in Cu content of electrolyte, g/l	8,5	14	15,5
Rich electrolyte content, g/l	42,5	50	51,5
Ext. solution pumping ratio in extraction O/A	1,2	0,35	0,24
Ext. solution pumping ratio in stripping O/A	8,5	3,8	3,2
Flow ratio of electrolyte and PLS	0,14	0,09	0,08

From this table the advantages given by our invention are apparent. In addition to the raised viscosity of the extraction solution and the fact that the solutions can be separated cleanly, it has been possible to reduce essentially the size of the equipment for handling the extraction solution in the extraction process, such as washing and stripping equipments, as well as other extraction solution equipment for the external circulation of the extraction solution, such as storage tanks and post-separators for separating the residue solutions. Likewise the size of the equipment for handling the electrolyte is reduced, such as flotation and pressure filtration apparatus, any possible post-separators and storage tanks. Another important factor is that the copper content can be raised, ensuring the quality of the copper.

15.

Example 3

In this example the performance values according to the prior art are shown in diagram 5 and the values of the method according to the present invention in diagrams 6 and 7, based on the presented stage calculations. These again show that the method helps reduce the size of the equipment considerably. The copper content of the aqueous solution is 3 g/l, i.e. still a dilute solution. The extractant content of an ordinary solution, given first in the table, is 8.5 vol.% and the following 15 and 25 vol.% according to this invention, as in the previous example. The extractant and diluting agent used are the same as in example 2. The temperature of the extraction solution is 18 °C.

Table 3

Quantity	Kuva 5	Kuva 6	Kuva 7
Extractant content, vol-%	8,5	15	25
Viscosity of extraction solution, cP	3	3,3	4,2
Cu content of raffinate, g/l	0,3	0,25	0,35
Rise in Cu content of extraction solution, g/l	2,4	4,5	6,3
Rise in Cu content of electrolyte, g/l	9,5	14	15,5
Rich electrolyte content, g/l	45,5	50	51,5
Ext. solution pumping ratio in extraction O/A	1,13	0,61	0,42
Ext. solution pumping ratio in stripping O/A	3,56	3,11	2,46
Flow ratio of electrolyte and PLS	0,29	0,2	0,17

5 Example 4

In this example, an aqueous solution was used with a Cu content of 6.5 g/l, in other words richer than is usually achieved with direct leaching of any poor ore. However, even when treating this kind of solution our method has distinct advantages. In the next table the stage calculations of diagrams 8, 9 and 10 were used. The contents of the extraction solution are 22, 30 and 40 vol.%, the extractant Acorga M6540 and the diluting agent again kerosene D70. The temperature of the extraction solution was 18 °C.

Table 4

Quantity	Fig. 8	Fig. 9	Fig. 10
Extractant content, vol-%	22	30	40
Viscosity of extraction solution, cP	3,7	4,9	6,3
Cu content of raffinate, g/l	0,2	0,3	0,4
Rise in Cu content of extraction solution, g/l	5,9	9,2	14,5
Rise in Cu content of electrolyte, g/l	16	16	16
Rich electrolyte content, g/l	52	52	52
Ext. solution pumping ratio in extraction O/A	1,07	0,67	0,42
Ext. solution pumping ratio in stripping O/A	2,71	1,74	1,1
Flow ratio of electrolyte and PLS	0,4	0,39	0,38

15

Example 5

This example studied the possibility of reducing the external pumping of the extraction solution considerably by raising its extractant content to a significantly high level. When the pH of the base solution is close to 2 and the

20

same aqueous solution contains sulphates, the extraction equilibrium is very beneficial when the copper content of the aqueous solution is low. In the case of the example the Cu content of the aqueous solution is 2.5 g/l, the pH is 1.8 and the amount of sulphates 50 g/l. According to this example the method of the present invention increases the copper extraction yield. As shown by the stage calculation in Fig.11, a very low raffinate content of 0.15 g/l copper is obtained while the external pumping of the extraction solution ratio drops to as low as 0.15. The external pumping of the electrolyte in ratio to the external pumping of the PLS also settles at the same value of 0.15. In this example the extractant used was the commercial chemical LIX 984N, which is similar to the reagent used in the previous example, and again kerosene D70 was the diluting agent. The extractant content was 50 vol.%.

Table 5

Quantity	Fig. 11
Viscosity of extraction solution, cP	8
Cu content of raffinate, g/l	0,15
Rise in Cu content of extraction solution, g/l	15,7
Rise in Cu content of electrolyte, g/l	16
Rich electrolyte content, g/l	52
Ext. solution pumping ratio in extraction O/A	0,15
Ext. solution pumping ratio in stripping O/A	1,02
Flow ratio of electrolyte and PLS	0,15

Example 6

The example shows how high the copper content of the PLS can be raised using our invention. In this example the Cu content of the PLS was raised up to 32 g/l while the extractant content of the extraction solution was raised to 50 vol.%, with Acorga M5640 as reagent and kerosene D70 as diluting agent. Mixing with the double helix mixer mentioned above is successful, even though an extractant content of as much as 40 – 70 vol.% is used. It is advantageous to do this when it is desired to reduce external pumping of the extraction solution. The stage calculation concerning 50 vol.% in Fig.12 and the summary in Table 6 clarify these possibilities further.

Table 6

Quantity	Fig. 12
Viscosity of extraction solution, cP	8,2
Cu content of raffinate, g/l	5
Rise in Cu content of extraction solution, g/l	13
Rise in Cu content of electrolyte, g/l	16,5
Rich electrolyte content, g/l	50,5
Ext. solution pumping ratio in extraction O/A	2,07
Ext. solution pumping ratio in stripping O/A	1,27
Flowratio of electrolyte and PLS	1,63

PATENT CLAIMS

1. A method for extraction of copper from an aqueous solution containing a large amount of sulphates in liquid-liquid extraction, **characterized in that**
5 the viscosity of an extraction solution is adjusted within the range of 3 – 11 cP and that the volumetric ratio of the extraction solution and an aqueous solution in an extraction mixture to between 0.7 – 1.0, whereby the aqueous solution is dispersed into drops in the extraction solution.
- 10 2. A method according to claim 1, **characterized in that** the viscosity of the extraction solution is raised by raising the content of an extractant.
3. A method according to claim 2, **characterized in that** the viscosity of the extraction solution is raised by regulating the extractant content of the
15 extraction solution in the range of 15 – 70 vol. %.
4. A method according to claim 1, **characterized in that** the ratio (O/A) between the organic solution and the aqueous solution coming to the extraction stage from outside is regulated in the range of 0.15 – 1.
20
5. A method according to claim 3, **characterized in that** in treating an aqueous solutions with a copper content of maximum 2 g/l, the viscosity of the extraction solution is raised by adjusting the content of the extractant in the extraction solution to the range of 15 – 25 vol.%.
25
6. A method according to claim 5, **characterized in that** the external pumping ratio of the extraction solution and the aqueous solution is adjusted to the range of 0.2 – 0.5 and the corresponding external pumping ratio between a stripped copper electrolyte and the aqueous solution of the extraction is
30 adjusted to the range of 0.08 – 0.02.

7. A method according to claim 3, characterized in that in treating an aqueous solution with a copper content of 2 – 4 g/l, the viscosity of the extraction solution is raised by adjusting the content of the extractant in the extraction solution to the range of 15 – 30 vol.%.
5
8. A method according to claim 7, characterized in that the external pumping ratio of the extraction solution and the aqueous solution is adjusted to the range of 0.3 – 0.7 and the corresponding external pumping ratio between the stripped copper electrolyte and the aqueous solution of the extraction is adjusted to the range of 0.15 – 0.25.
10
9. A method according to claim 3, characterized in that in treating an aqueous solution with a copper content of 4 – 8 g/l, the viscosity of the extraction solution is raised by adjusting the content of the extractant in the extraction solution to the range of 25 – 50 vol.%.
15
10. A method according to claim 9, characterized in that the external pumping ratio of the extraction solution and the aqueous solution is adjusted to the range of 0.4 – 0.8 and the corresponding external pumping ratio between the stripped copper electrolyte and the aqueous solution of the extraction is adjusted to the range of 0.25 – 0.50.
20
11. A method according to claim 3, characterized in that in treating an aqueous solution with a copper content of over 8 g/l, the viscosity of the extraction solution is raised by adjusting the content of the extractant in the extraction solution to the range of 40 – 70 vol.%.
25
12. A method according to claim 11, characterized in that the external pumping ratio of the extraction solution and the aqueous solution is adjusted within the range of 1 – 4 and the corresponding external pumping ratio between the stripped copper electrolyte and the aqueous solution of
30

the extraction is adjusted within the range of 0.8 – 3.

13. A method according to claim 1, characterized in that the viscosity of the extraction solution is raised by using alifatic hydrocarbons, kerosenes, with a viscosity of 2.7 – 3.2 cP when measured at ambient temperature, as diluting agent for the extraction solution.
14. A method according to claim 1, characterized in that the viscosity of the extraction solution is raised by using aromatic hydrocarbons, kerosenes, with a viscosity of about 3 cP when measured at ambient temperature, as diluting agent for the extraction solution.
15. A method according to any of the above claim, characterized in that the viscosity of the extraction solution is raised by using a mixture of alifatic and aromatic hydrocarbons, with a viscosity of minimum 2.7 cP when measured at ambient temperature, as diluting agent for the extraction solution.
16. A method according to claim 1, characterized in that the sulphate content of the aqueous solution fed to solvent extraction is minimum 40g/l.
17. A method according to any of the above claim, characterized in that the extracting solutions flow through each stage of the extraction equipment at essentially the same time.
18. A method according to any of the above claim, characterized in that the extracting solutions flow through the washing and stripping stages of the equipment more slowly than the actual extracting stages.

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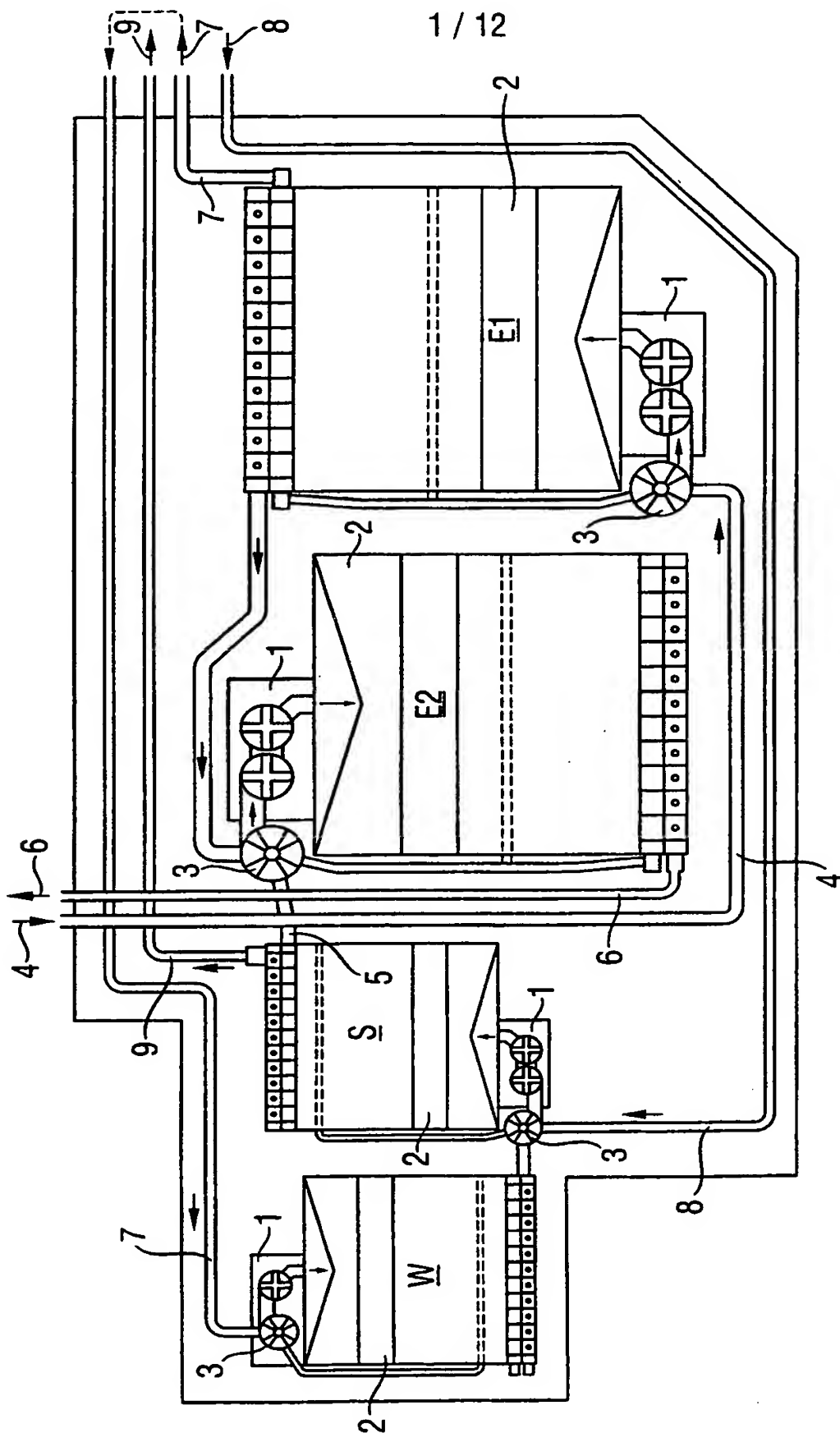
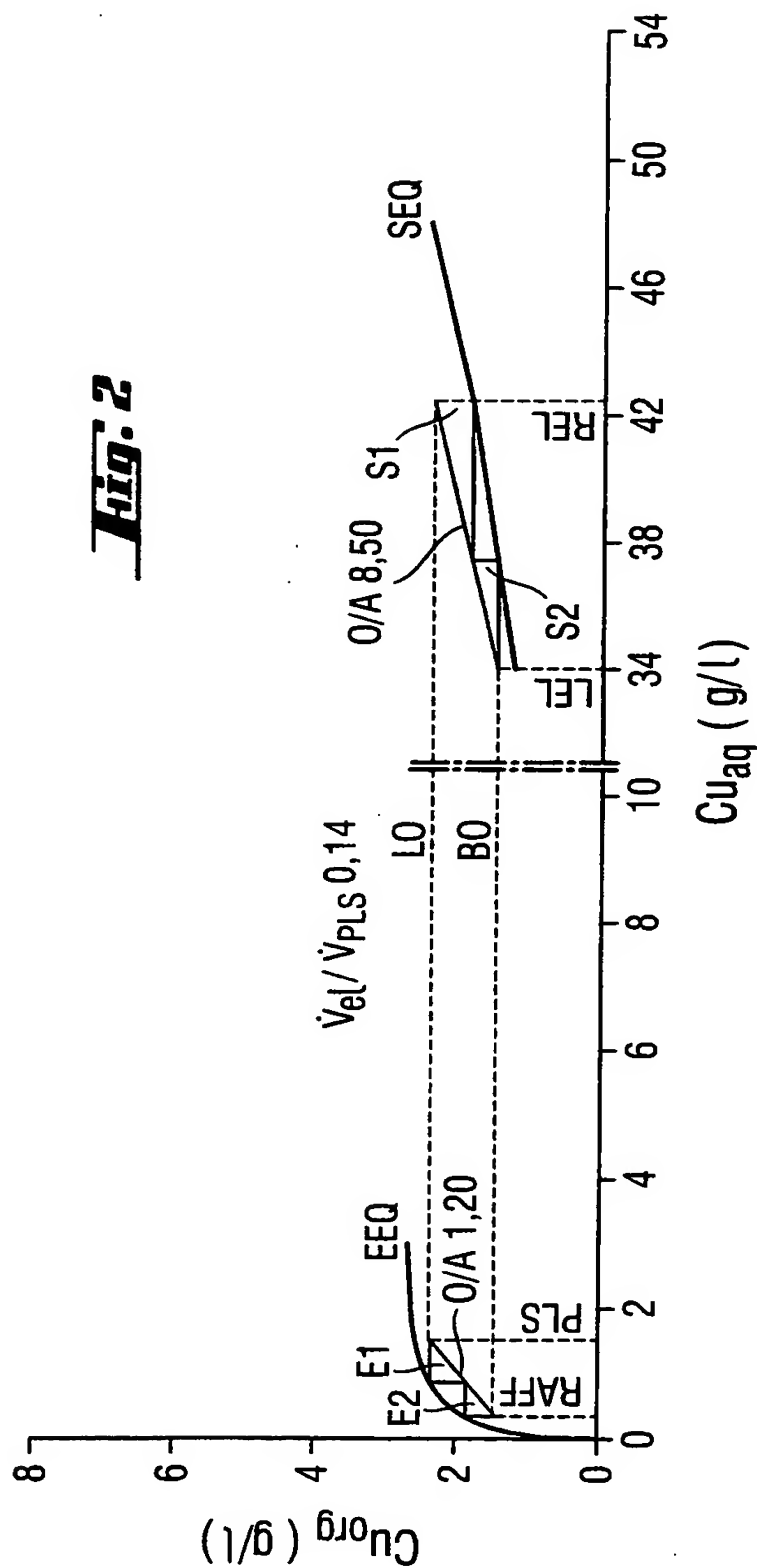
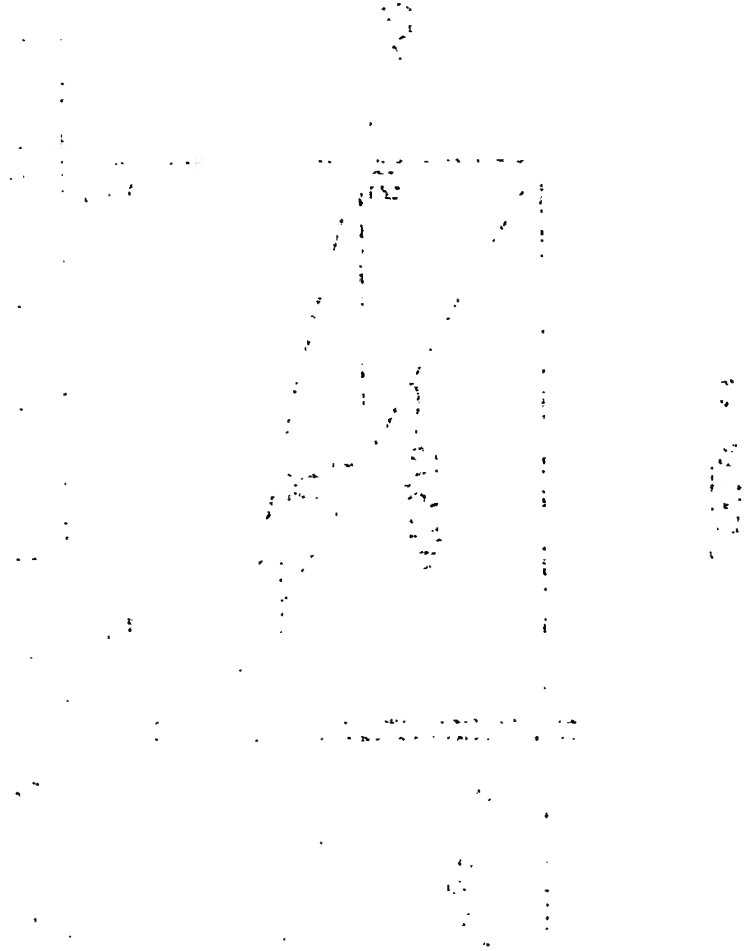


Fig. 1

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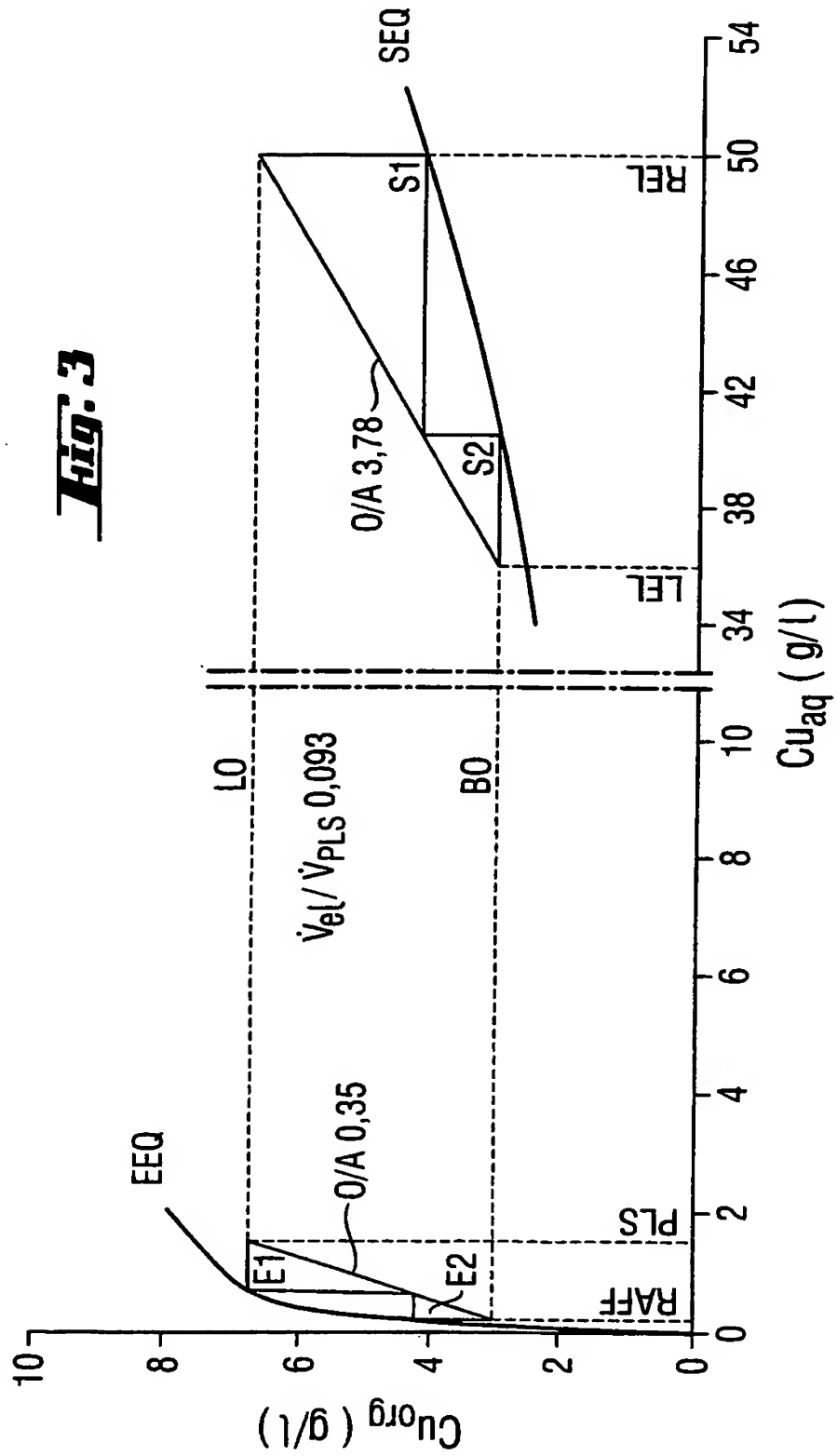
Fig. 2

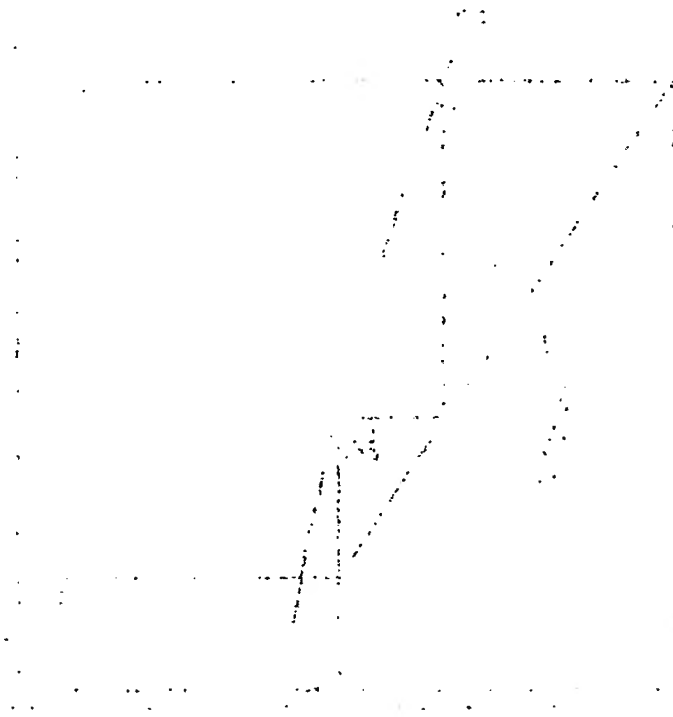




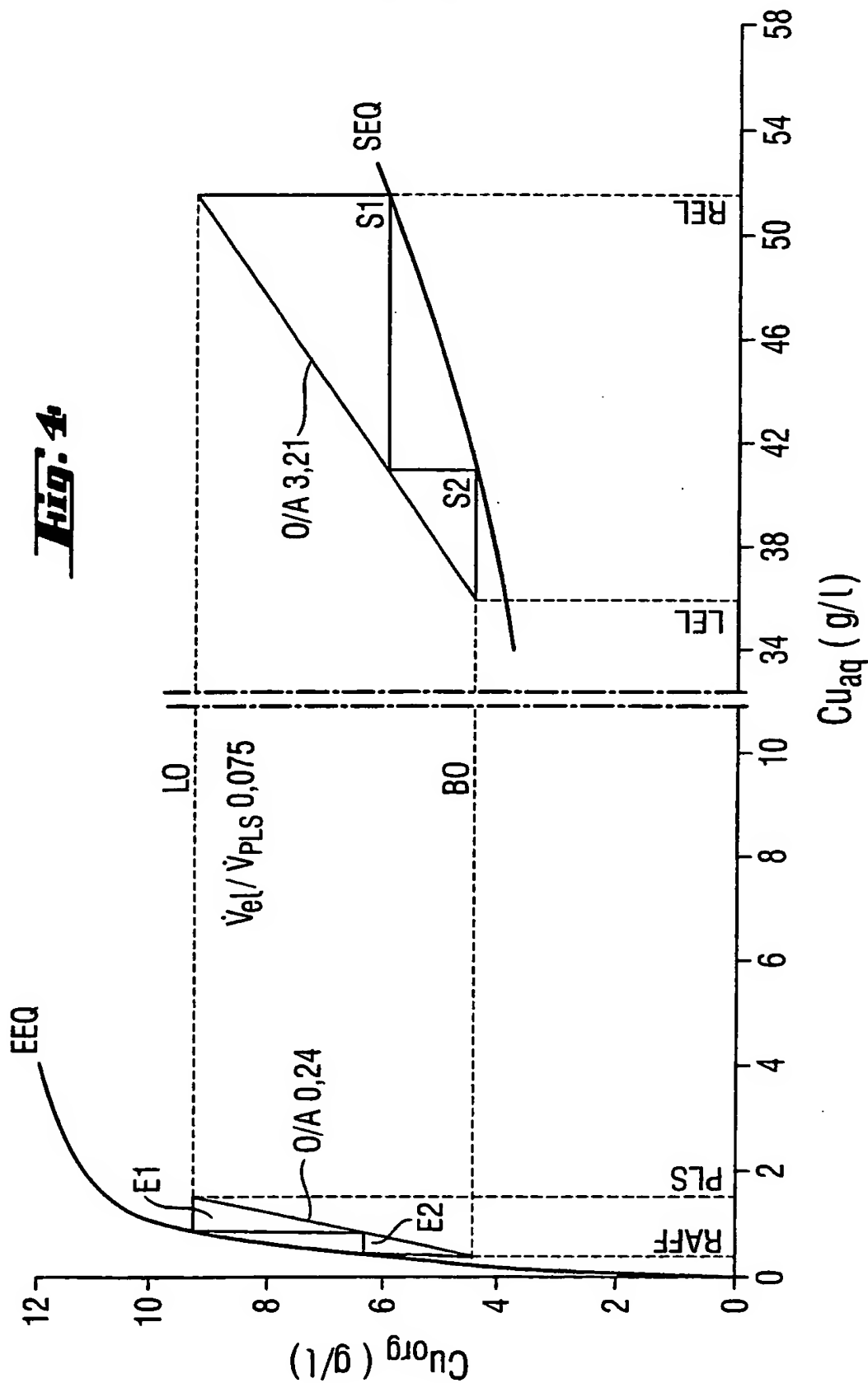
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Fig. 3



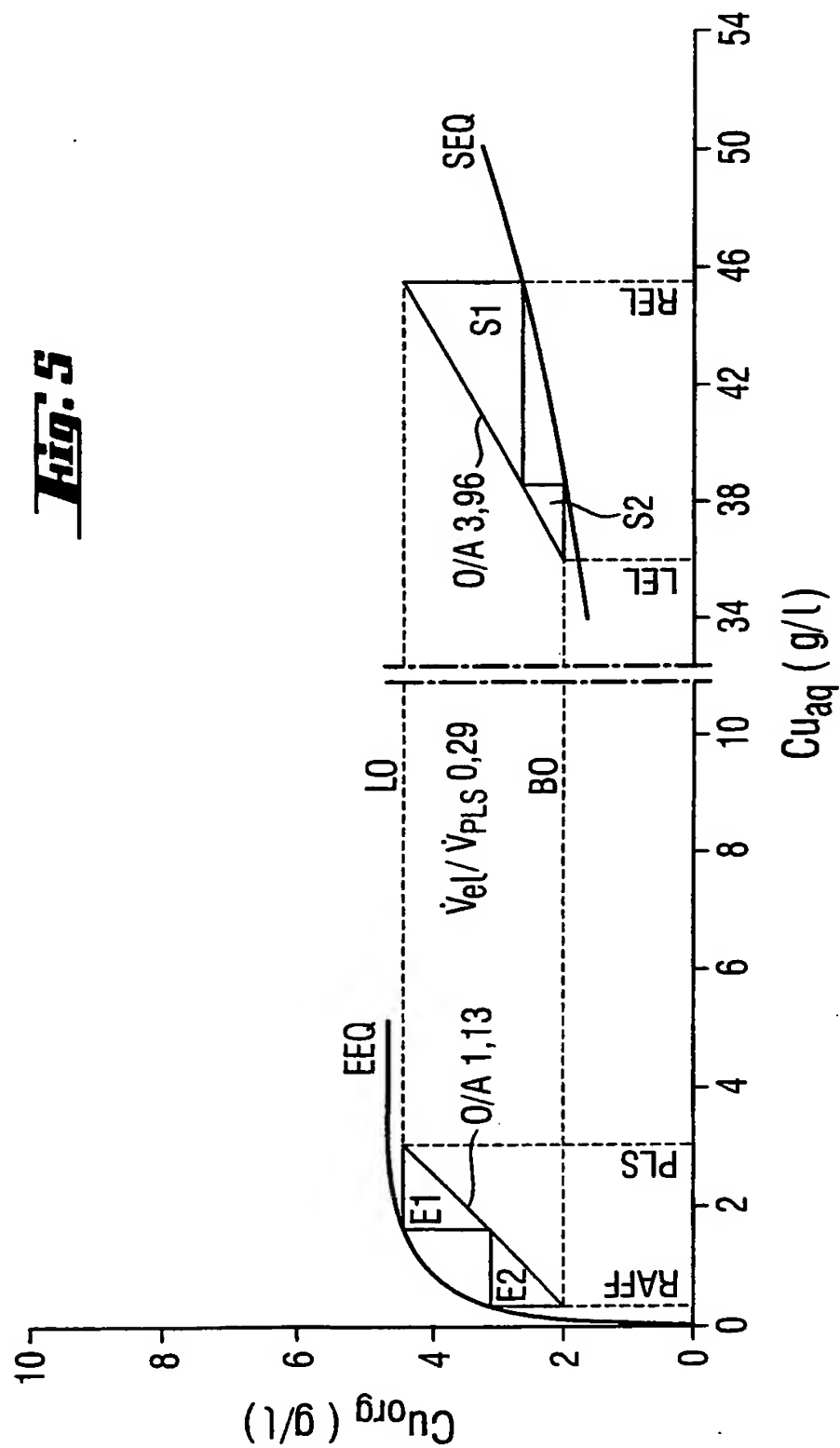


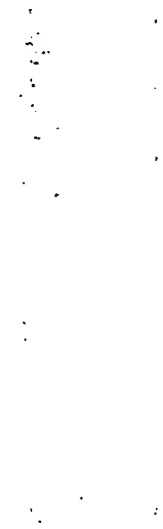
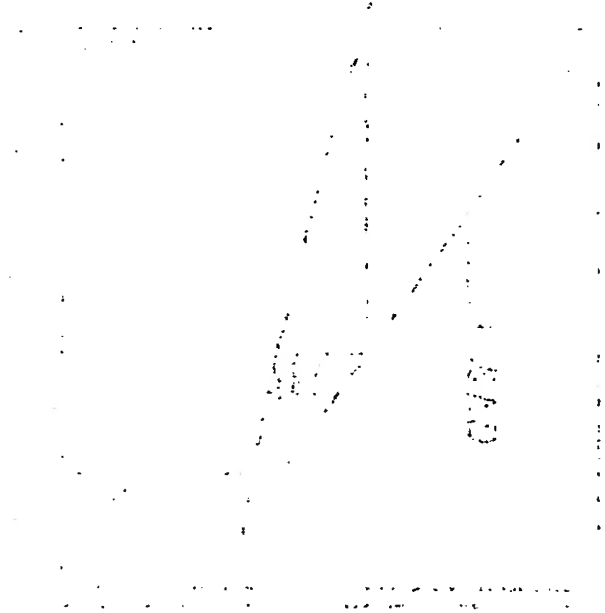
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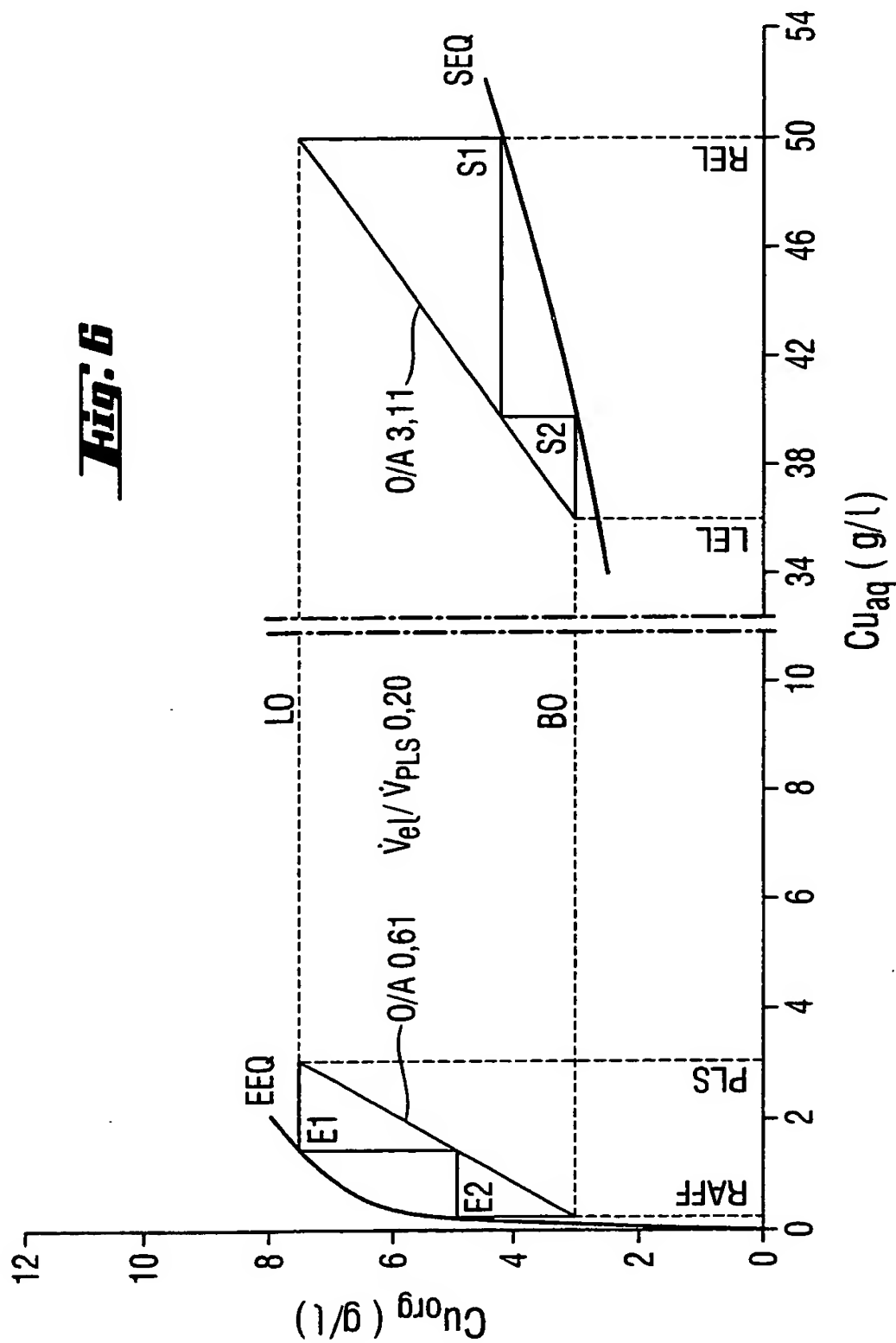
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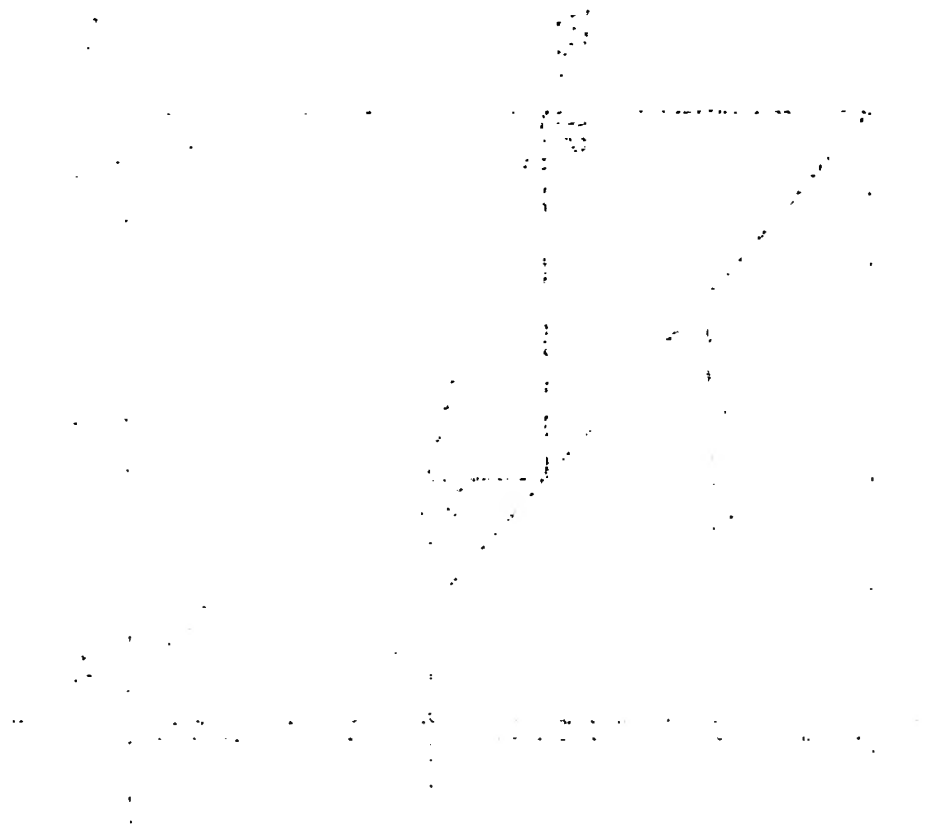
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Fig. 5

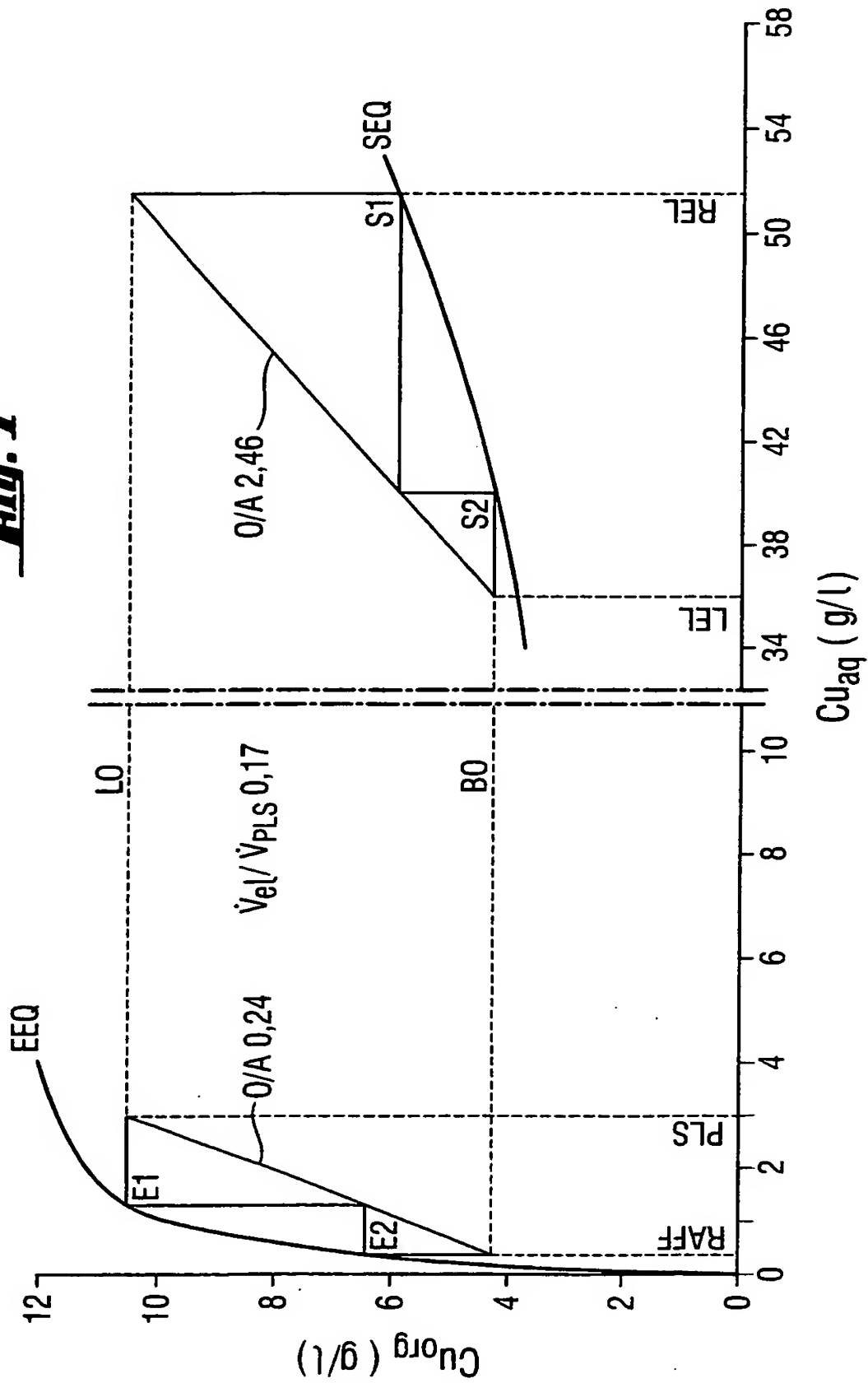


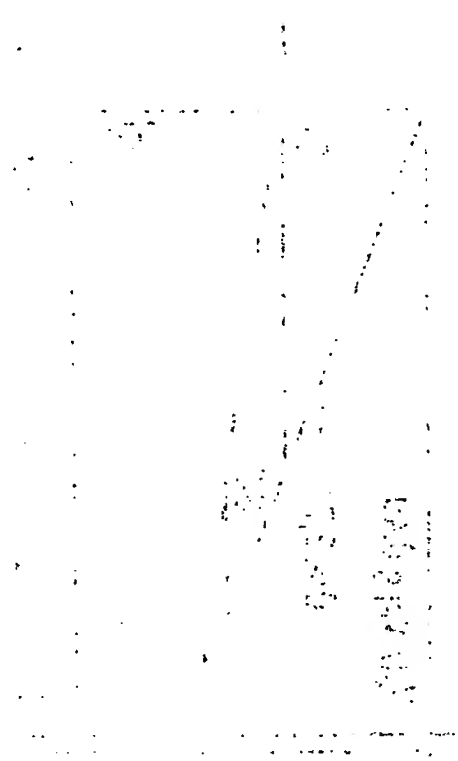
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Fig. 6



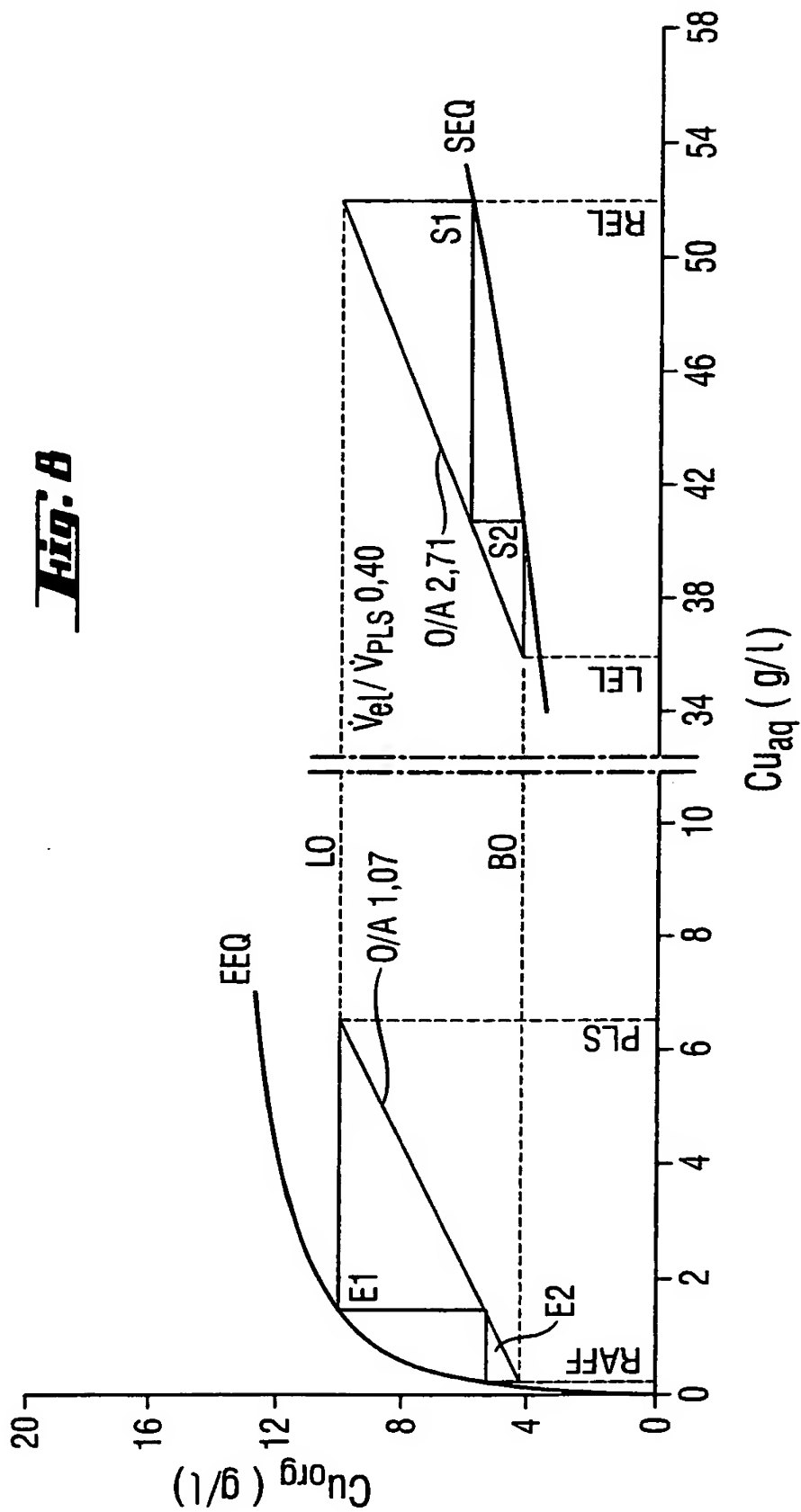
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Fig. 1



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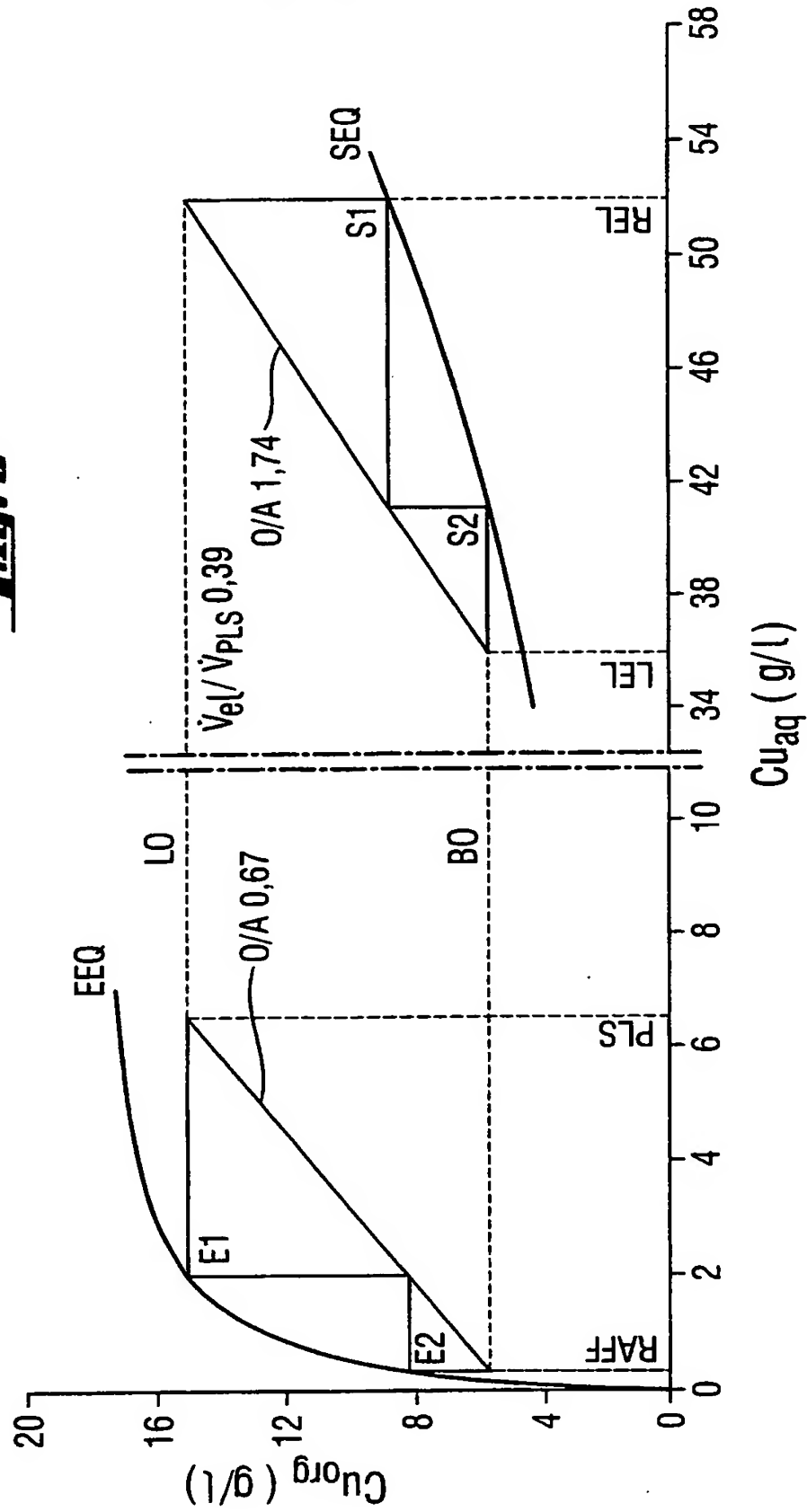
Fig. 8

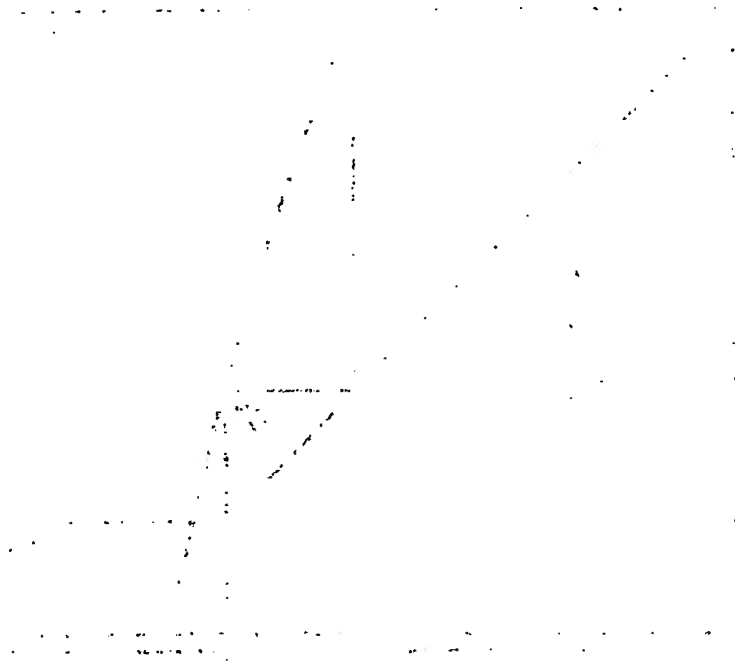




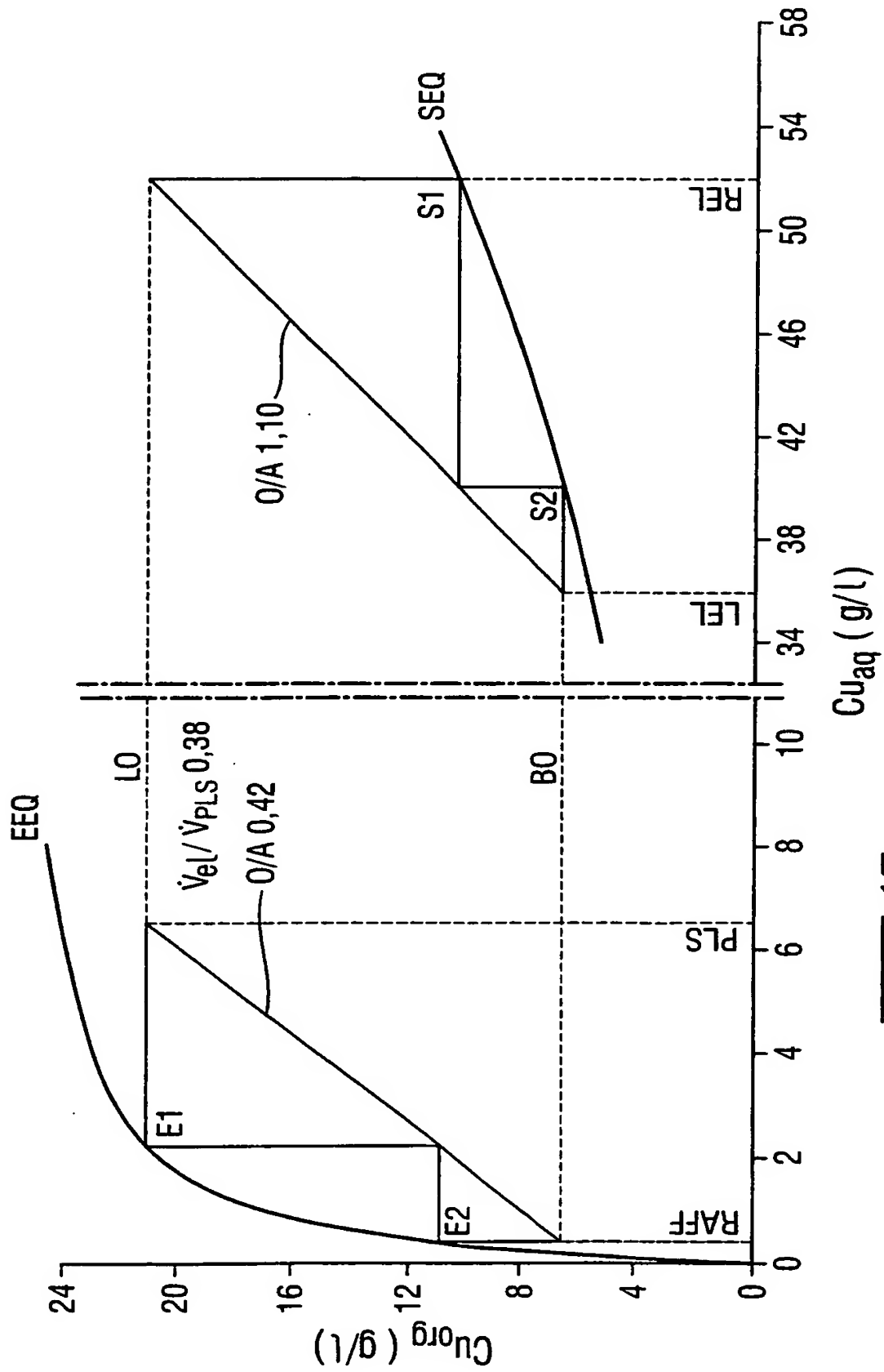
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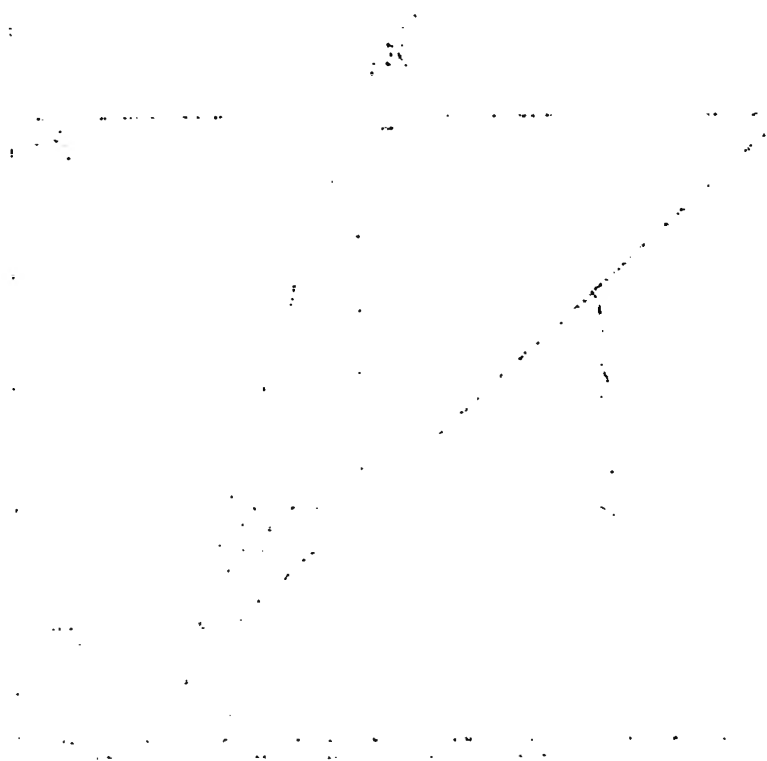
Fig. 9





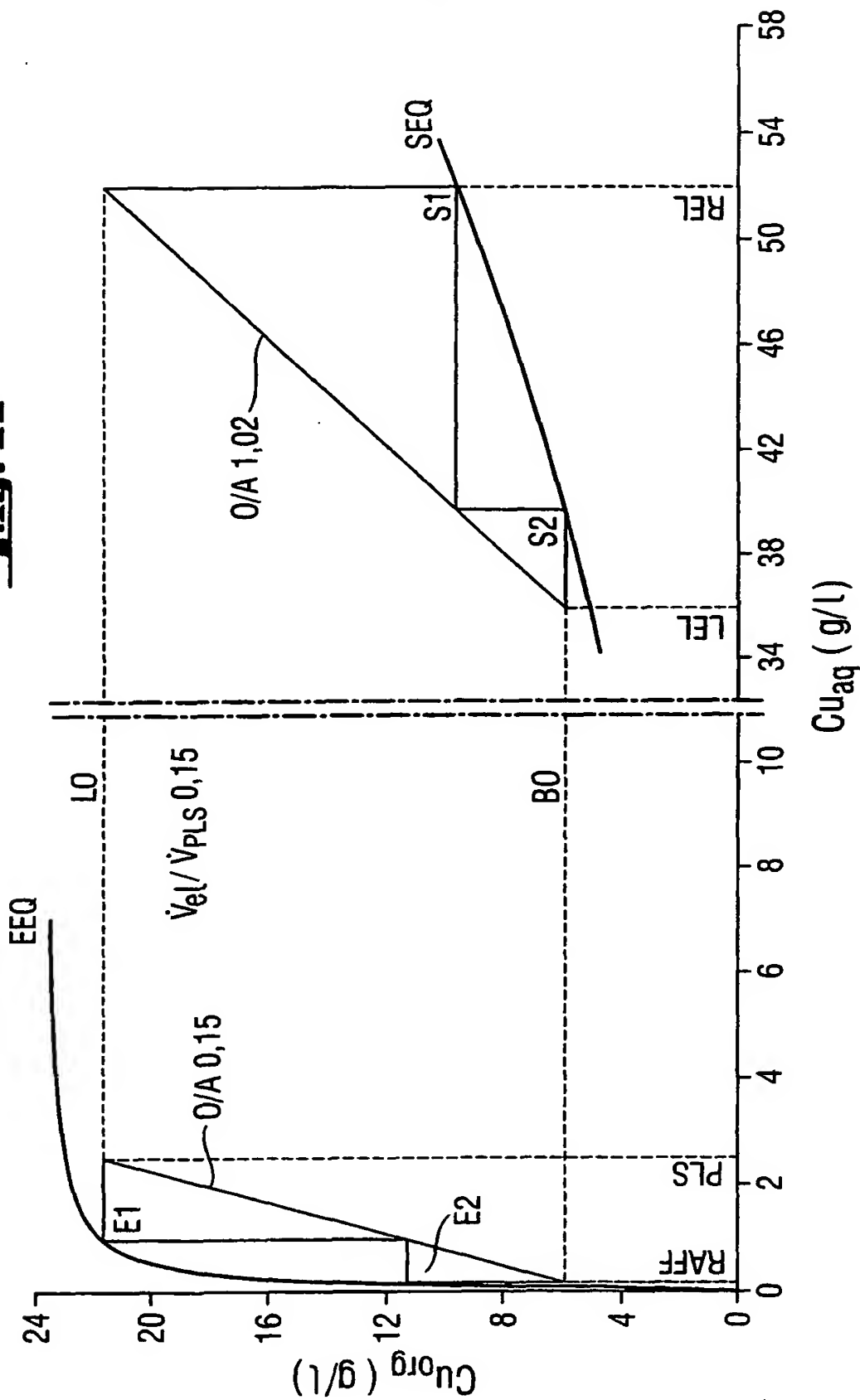
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**Fig. 10**

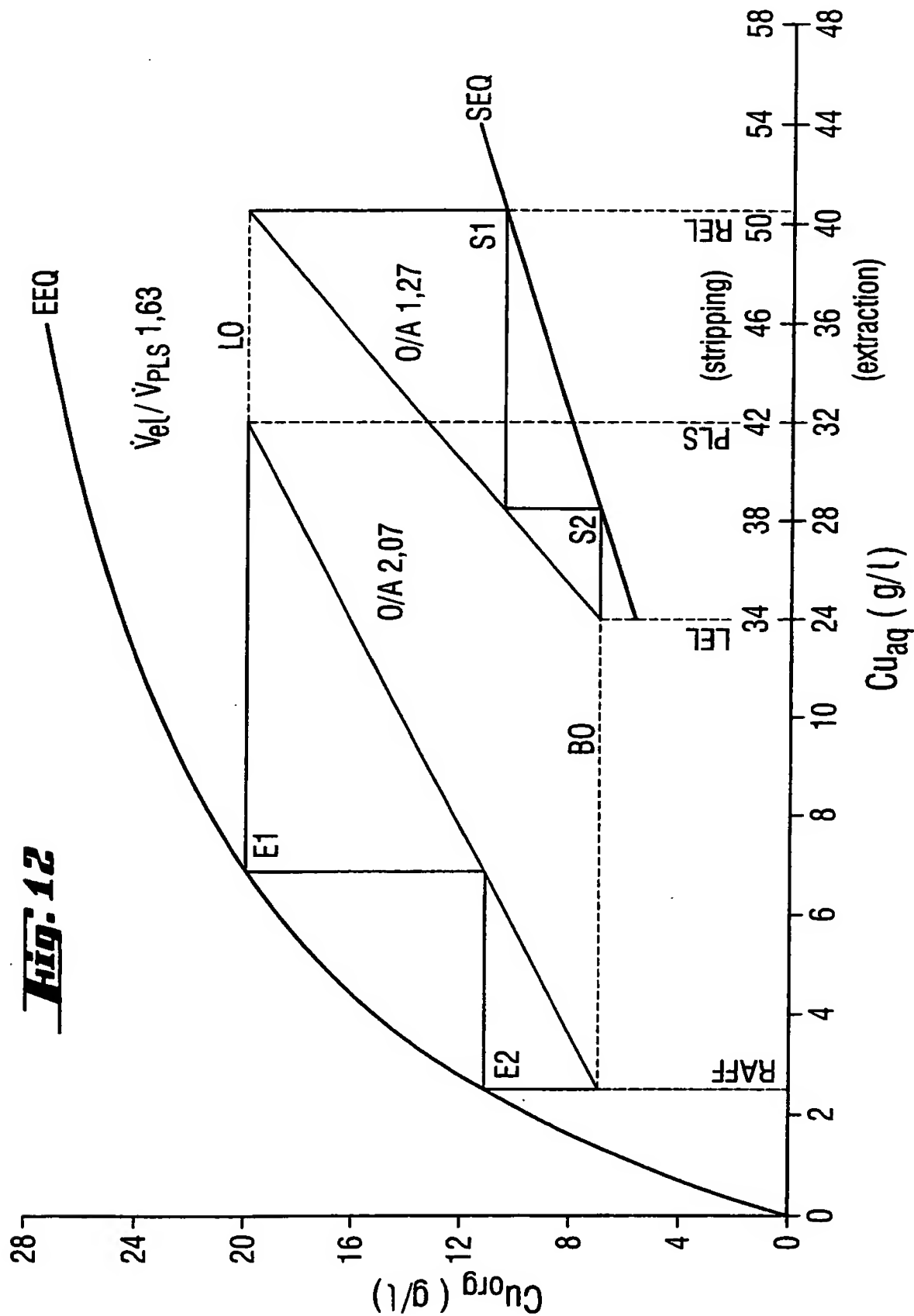


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Fig. 11



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1. The present invention relates to a method of
determining the position of a point in a 3D space
using a set of three orthogonal planes.

2. The method of the present invention is based on the
principle that the intersection of three orthogonal
planes is a single point. This point is the
position of the point in the 3D space.

3. The method of the present invention is based on the
principle that the intersection of three orthogonal
planes is a single point. This point is the
position of the point in the 3D space.

4. The method of the present invention is based on the
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00397

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01D 11/04, C22B 3/26 // C22B 15:00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B01D, B01F, C22B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI,PAJ,EDOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2117666 A (UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY), 19 October 1983 (19.10.83), claims 1,9, abstract --	1-8
X	US 4221658 A (WILLIAM E. HARDWICK), 9 Sept 1980 (09.09.80), claims 1-2 --	1-18
A	US 5662871 A (BROR NYMAN ET AL), 2 Sept 1997 (02.09.97), abstract --	1-18
A	US 5185081 A (BROR G. NYMAN ET AL), 9 February 1993 (09.02.93), claim 1, abstract --	1-18

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

11 Sept 2000

Date of mailing of the international search report

15 -09- 2000

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Lars Ekeberg/MP

Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

08/05/00

International application No.

PCT/FI 00/00397

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
GB	2117666	A	19/10/83	NONE		

US	4221658	A	09/09/80	AU	3341578 A	30/08/79
				BE	864132 A	16/06/78
				BR	7801000 A	02/01/79
				CA	1094296 A	27/01/81
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				SE	7801893 A	22/08/78
				ZA	7800967 A	28/02/79
				ZM	1978 A	21/11/78

US	5662871	A	02/09/97	AU	686250 B	05/02/98
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				BR	9404833 A	01/08/95
				CA	2137128 A	03/06/95
				CN	1050522 B	22/03/00
				CN	1110992 A	01/11/95
				FI	96968 B,C	14/06/96
				FI	935393 A	03/06/95
				ZA	9409133 A	24/07/95

US	5185081	A	09/02/93	AU	638562 B	01/07/93
				AU	7395191 A	10/10/91
				CA	2039676 C	06/12/94
				FI	88773 B,C	31/03/93
				FI	901691 A	05/10/91
				MX	173225 B	09/02/94
				TR	26467 A	15/03/95

Received

WO 00/69538
PCT/FI00/00397

PATENT COOPERATION TREATY

30.11.00

PCT

From the INTERNATIONAL BUREAU

NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:

OUTOKUMPU OYJ
Patent Services
P.O. Box 27
FIN-02201 Espoo
FINLANDE

Date of mailing (day/month/year)

23 November 2000 (23.11.00)

Applicant's or agent's file reference

991111 WO

IMPORTANT NOTICE

International application No.

PCT/FI00/00397

International filing date (day/month/year)

04 May 2000 (04.05.00)

Priority date (day/month/year)

14 May 1999 (14.05.99)

Applicant

OUTOKUMPU OYJ et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:

AU,KP,KR,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

AE,AL,AM,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CU,CZ,DE,DK,EA,EE,EP,ES,FI,GB,GD,GE,GH,GM,
HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MD,MG,MK,MN,MW,MX,NO,NZ,PL,PT,
RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,UA,UG,UZ,VN,YU,ZA,ZW

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 23 November 2000 (23.11.00) under No. WO 00/69538

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

J. Zahra

Telephone No. (41-22) 338.83.38



PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

Outokumpu OYJ Intellectual
Property Management
P.O. Box 27
FIN-02201 Espoo
Finland

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing (day/month/year)	01-06-2001
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Applicant's or agent's file reference 991111 WO	IMPORTANT NOTIFICATION
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International application No. PCT/FI00/00397	International filing date (day/month/year) 04-05-2000	Priority date (day/month/year) 14-05-1999
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Applicant Outokumpu Oyj et al	
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1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/ Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Telex 17978 PATOREG-S
--	-----------------------------

Authorized officer

Ihla Rönnerberg

Telephone No. 08-782 25 00



THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES

REPORT OF THE
COMMISSIONER OF THE
BUREAU OF MINES
ON THE
PROGRESS OF THE
WORK DURING THE
YEAR 1907

BY
JOHN W. COVILLE

CHIEF OF THE
BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR
WASHINGTON, D. C.

1908

PRINTED BY THE
GOVERNMENT PRINTING OFFICE

WASHINGTON, D. C.

1908

1908

1908

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 991111 WO	FOR FURTHER ACTION		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FI00/00397	International filing date (day/month/year) 04.05.2000	Priority date (day/month/year) 14.05.1999	
International Patent Classification (IPC) or national classification and IPC7 B01D 11/04, C22B 3/26 // C22B 15:00			
Applicant Outokumpu Oyj et al			

1.	This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2.	This REPORT consists of a total of <u>4</u> sheets, including this cover sheet. <input type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT). These annexes consist of a total of _____ sheets.
3.	This report contains indications relating to the following items: I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability, citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input type="checkbox"/> Certain defects in the international application VIII <input type="checkbox"/> Certain observations on the international application

Date of submission of the demand 29.11.2000	Date of completion of this report 15.05.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Lars Ekeberg/js Telephone No. 08-782 25 00



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00397

I. Basis of the report

1. With regard to the elements of the international application:*

☒ the international application as originally filed

☐ the description:

pages _____, as originally filed

pages _____, filed with the demand

pages _____, filed with the letter of _____

☐ the claims:

pages _____, as originally filed

pages _____, as amended (together with any statement) under article 19

pages _____, filed with the demand

pages _____, filed with the letter of _____

☐ the drawings:

pages _____, as originally filed

pages _____, filed with the demand

pages _____, filed with the letter of _____

☐ the sequence listing part of the description:

pages _____, as originally filed

pages _____, filed with the demand

pages _____, filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00397

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-18</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-18</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-18</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The invention according to claims 1-18 relates to a method for extraction of copper from an aqueous solution containing a large amount of sulphates in liquid-liquid solution. The viscosity of the extraction solution lies between 3 and 11 cP. The between the extraction solution and the aqueous solution is situated between 0.7 and 1.0.

The following documents are, among others, cited in the International Search Report:

D1: GB 2 117 666 A

D2: US 4,221,658 A

D3: US 5,662,871 A

D4: US 5,185,081 A

Of these documents D1 and D2 were considered to be of particular relevance, while D3 and D4 only were considered to represent the general state of the art, and are therefore not discussed in this report. However, the importance of D1 and D2 have been re-evaluated. They are now only considered to represent the general state of the art.

From D1, a method for hydrometallurgical extraction of copper is known. The ratio between the extraction solution and the aqueous solution is preferably situated around 1.0 (claim 9).

Another extraction method is known from D2. In both D1 and D2 the preferred volume ratio is situated between 0.2 and 5. Nothing is, on the other hand, said about the viscosity, in neither of the documents. It is not suggested that an augmentation of the viscosity could have a positive influence on the extraction.

.../...



[Faint, illegible text spanning the upper half of the page, possibly a list or a series of short paragraphs.]

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00397

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V (I)

Although it is difficult to estimate the viscosity of the solutions used in D1 and D2, the invention is considered to involve an inventive step with regard to both of these documents. Claims 2 -18 are dependent on the first claim, hence, these claims are also considered to possess an inventive step.

In view of the argument stated above, the invention as a whole is novel and considered to involve an inventive step. It is also considered to fulfil the criteria of novelty and industrial applicability.



4

CHAPTER I

The first part of the book is devoted to a general survey of the history of the world, from the beginning of time to the present day. The author begins with the creation of the world, and then proceeds to describe the various stages of human civilization, from the earliest times to the present. He discusses the different races of men, their customs, and their progress. He also touches upon the various religions and philosophies that have shaped the world. The second part of the book is devoted to a detailed account of the history of the United States, from its discovery to the present. The author describes the early settlements, the struggle for independence, and the growth of the nation. He also discusses the various wars and conflicts that have shaped the country. The third part of the book is devoted to a description of the present state of the world, and the author's views on the future. He discusses the various problems that face the world, and offers his own solutions. The book is written in a simple, straightforward style, and is intended for a general audience. It is a valuable work of history, and one that should be read by all who are interested in the world and its people.

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